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PALEOPHYTOGEOGRAPHY OF THE ANGIOSPERM POLLEN GRAINS DURING THE UPPER CRETACEOUS AND THE TERTIARY I

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Abstract

The Upper Cretaceous — Paleogene paleophytogeographical regions are based on the distribution of the pollen grains of *Normapolles, Triprojectacites, Oculata* Group, *Proteaceae, Ulmaceae,* and *Olacaceae*. The pollen group *Postnormapolles* was not sufficiently studied from this point of view. This paper deals with the regional distribution during the geological past of one form-species of early type from the genuses *Triatriopollenites* and *Triporopollenites*, all species of the genus *Platycaryapollenites* and *Paraalnipollenites. Triatriopollenites roboratus* has the most restricted area and occurrence in the geological time units, namely this species occur in the Paleocene — Eocene of Eurasia. *Triporopollenites robustus* is also mostly from Paleocene — Eocene age but there are scattered data from the Upper Cretaceous and from the Eocene until the Miocene. This species occur not only in Eurasia, but in North-America and North-Africa too. The pollen grains of the genus *Paraalnipollenites* were mainly the elements of the province *Aquilapollenites*, and the intermediate region, its occurrence in the *Normapolles* province is scarce. This form-genus seems to be charasteristic for the Upper Cretaceous, Paleocene and Eocene time, but there are data from younger sediments too. The pollen grains of the genus *Platycaryapollenites* appear in the Upper Cretaceous (North-Africa). It is very common in the Paleocene, but its largest distribution is during the Eocene, important in the Oligocene. During the Neogene its area become restricted gradually. From the Pliocene it is only a single occurrence from the Southern Hemisphere from a deep sea drilling near the Timor Islands.The pollen grains analyzed in this paper may be derived from the *Normapolles* group. But its distribution overstep the boundaries of the *Normapolles* taxa, in this way its radiation was very rapid during the Upper Cretaceous and the lower part of the Paleogene.
Key words: Palynology, Paleophytogeography, Cretaceous — Tertiary.

Introduction

The study of the regional distribution of several sporomorph taxa during the geological past may be considered as a method in Palynology. SAKS et al., (1973) emphasized that these investigations are important in the reconstruction of the paleophytogeographical environments, and in the establishment of the paleoclimatic zones and the paleopole. As pioneering publications, dealing with the Upper Cretaceous — Paleogene regions based on palynological data the importance of the paper of KRUTZSCH (1960) and ZAKLINSKAYA (1962) must be emphasized. Concerning the paleophytogeographical units, which were established in these classical publications, later several supplementary data were published by several

authors: MTCHEDLISHVILI and SAMOILOVICH (1962), ZAKLINSKAYA (1963, 1966, 1967a,b, 1976), SHAKHMOUNDES (1966), SAMOILOVICH (1967), KEDVES and KIRÁLY (1968, 1970), STANLEY (1970), KHLONOVA (1971), WIGGINS (1976), SRIVASTAVA (1978), and BATTEN (1981). As comprehensive papers, the publications of MÉDUS (1973), HERNGREEN and KHLONOVA (1981) and KEDVES and DINIZ (1983) may be mentioned. Important data were published on this point of view by ROCHE (1974). A new paleophytogeographical synthesis for the Upper Cretaceous was published by the present writer (KEDVES 1985). The paleophytogeographical provinces and districts for the Paleocene, Eocene and Oligocene were elaborated by BOITSOVA and PANOVA (1973).

During the Tertiary, the extraordinarily differentiated Upper Cretaceous and Paleogene floras were altered, with a more uniform vegetation. The early angiosperms disappeared, these taxa are represented first in Europe by the *Normapolles* group, which has a very complicated germinal exine structure. Its place was occupied by the *Postnormapolles*, by the developed types of the *Longaxones*, and other different kinds of angiosperms.

The pollen group of the *Postnormapolles* may be derived at least in its greater part from the *Normapolles*. But these pollen grains occur not only in the *Normapolles* (European — Turanian; KHLONOVA, 1971) province, but in such territories where *Normapolles* have not existed, or their occurrence is very scarce. In the case of some *Postnormapolles* a heterogeneous origin may be presumed. This

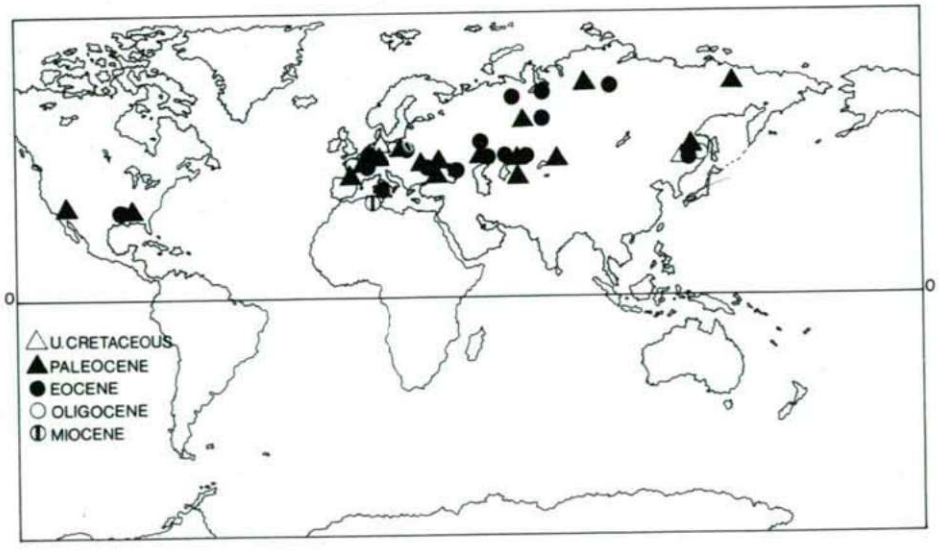


Fig. 1. Regional distribution of *Triporopollenites robustus* PF. 1953 during the Upper Cretaceous and the Tertiary.

problem was focussed during our present research project, by the way of the regional and chronological distribution of several form-species and form-genuses. This paper summarizes the first results concerning this subject.

Methods

The literature data, which were available for us was evaluated and documented for each taxa. During the collection of the data, the following problems arise:

1. In several cases there are doubts in the determinations of the sporomorphs.
2. In some papers the precision of the geological age of the spore-pollen assemblage is not satisfactory.
3. Sometimes it was not easy to establish the localities. On the other hand there were given very large territories, on the other so small geographical objects were given, which are not indicated on the large world maps.

It was impossible to indicate all the collected data, because the proportion size of our map. But the principal goal was, that each of the most important data for the paleophytogeographical evaluation were indicated on the map.

The objects of this paper were the triporate, and triatriate pollen grains as the most primitive types of the *Postnormapolles*.

Results

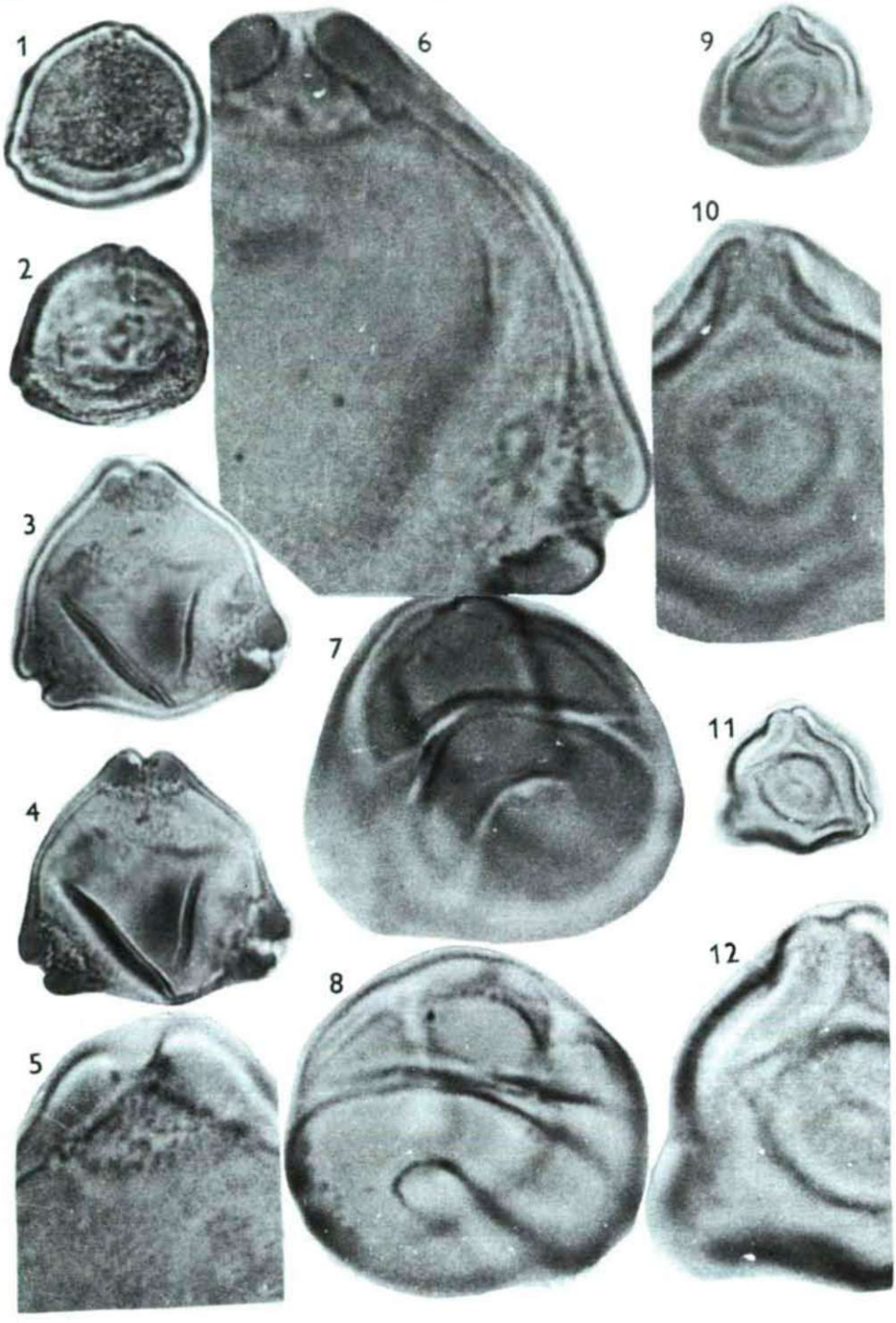
Fgen.: *Triporopollenites* PF. et TH. 1953

Triporopollenites robustus PF. 1953 subfsp. *robustus, Betulaceae,* (Plate I, fig. 1,2)

This kind of pollen grain is a very early triporate type, which probably may be distinguished taxonomically from the other developed pollen grains of this morphological type. TEM data about this species were published by KEDVES and PÁRDUTZ (1970), and by KEDVES and STANLEY (1976), this latter paper deals with the results of the SEM studies too.

The appearance of this form-species is the Upper Cretaceous, we have data from Europe, and from the Far East, in this way this species appeared in the *Normapolles* and *Aquilapollenites* province at the same time (fig. 1). It is worthy to mention that it is not yet known from the intermediate zone between the *Normapolles* and *Aquilapollenites* province in Eurasia, and from North America too. During the Paleocene and Lower Eocene firstly in the lower Eocene in Eurasia the distribution of this species is common. From North America only Paleocene and few Lower Eocene data are known. We have data from the Oligocene of Europe, and from the Far East, but the re-study of these specimens may alter our present-day knowledge concerning the occurrence of this species. The Miocene data from North America is in question.

As regards the origins of this pollen type the *Normapolles* group may be taken first into consideration. But on the basis of its occurrence in the Paleocene it may not be presumed that this species radiated from the European gene centrum to Siberia. Our earlier results (KEDVES and DINIZ, 1979) reveal that between the *Normapolles*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and *Postnormapolles* group there are a number of intermediate types and it may be presumed that it is necessary to create a new group for some early *Brevaxones* pollen grains, which occur not only in the *Normapolles,* but in the *Aquilapollenites* province. On the other hand, the common taxa of the established paleophytogeographical units did not yet come into the limelight, because the subject of the researchers were firstly the segregate angiosperm pollen types.

Fgen.: *Triatriopollenites* PF. 1953

Triatriopollenites roboratus PF. 1953, *Myricaceae* (Plate I, fig. 3—6)

Syn.: 1960 SAUER, in POKROVSKAYA et STELMAK. — *Myrica mirabilis,* sp. nov., p. 412. pl. V, fig. 9a,b.

Its characteristic atrium (Plate I, fig. 5,6) and the exoaperture elongated in polar direction refer to an early *Brevaxones* origin. It is regretful that about this very important pollen grain we have not yet transmission electron microscopical data.

This species is important from stratigraphical point of view of the Paleocene and the Lower Eocene (fig. 2). In contrast to the occurrence in the Paleocene and Lower Eocene layers of the Far East, based on our present day knowledge, this is an element of the *Normapolles* province as an attending of the *Normapolles* taxa. It is noteworthy that against the widespread researches it is not yet found in North America. In this respect, this species has the identic, regional, and pro parte stratigraphic value, with the genus *Stephanoporopollenites,* having a decisive importance in Europe and in the intermediate region in the determination of the Paleocene age, and similarly not yet demonstrated from North America either (KEDVES, 1977). The difference between the stratigraphic value of *Triatriopollenites roboratus,* and the form-genus *Stephanoporopollenites* is, that the taxa of the latter mentioned genus occurred never in the sediments younger as Thanetian in contrast to the Lower Eocene (Sparnatian) occurrence of *Triatriopollenites roboratus.*

Plate I

1,2 *Triporopollenites robustus* PF. 1953 subfsp. *minor* KDS. 1970, cf. *Betulaceae,* slide: Menat-2, cross-table number: 14.7/116.6, following KEDVES and RUSSELL (1982), x1000

3,4 *Triatriopollenites roboratus* PF. 1953, slide: Menat-8, cross-table number: 18.3/120.9, following KEDVES and RUSSELL, (1982) x1000

5,6 *Triatriopollenites roboratus* PF. 1953, slide: Menat-26, cross-table number: 14.6/103.7, following KEDVES and RUSSELL (1982), x2500

7,8 *Platycaryapollenites swasticoidus* (ELSIK 1974) FRED. et CHRIST. 1978, *Juglandaceaea, Platycarya,* slide: Menat-39, cross-table number: 14.2/111.3, following KEDVES and RUSSELL (1982), x2500

9,11 *Paraalnipollenites alterniporus* (SIMPS. 1961) SRIV. 1975, slide: Menat-37, cross-table number: 16.9/117.1, x1000

10,12 *Paraalnipollenites alterniporus* (SIMPS. 1961) SRIV. 1975, slide: Menat-37, cross-table number: 16.9/117.1, x2500

Fgen.: *Platycaryapollenites* E. NAGY 1969 emend. FREDERIKSEN et CHRISTOPHER 1978

Platycaryapollenites swasticoidus (ELSIK 1974) FRED. et CHRIST. 1978, *Juglandaceae, Platycarya* (Plate I, fig. 7,8)

The morphology of these pollen grains is very characteristic. TEM and SEM data about this form-genus were published by KEDVES and STANLEY (1976). The importance of the regional distribution of the pollen grains of this form-genus is supported by the fact that we have publications from this point of view; LEOPOLD and MACGINITIE (1972), GRUAS-CAVAGNETTO (1977). Following ZAKLINSKAYA (1962) the appearance of the genus Platycarya was in the Upper Cretaceous. From Upper Cretaceous layers of Egypt, KEDVES (1971) published as a preliminary report pollen grains belonging to this form-genus. KEDVES and DINIZ (1979) from the layers of Aveiro type spore-pollen assemblage (Santonian-Campanian, Portugal) published cf *Platycaryapollenites semicyclus*, because its endoaperture differ from the pollen grains of the Paleocene and Eocene sediments. In this way the appearance and especially the distribution needs further investigations. It is worthy of mentioning in this place too, that the studies of the sporomorphs of the Upper Cretaceous sediments were interested first in the researches of the *Normapolles* and *Aquilapollenites (Triprojectacites)*, which have a peculiar exine structure.

The regional distribution of the fossil forms of the genus *Platycarya* was published by LEOPOLD and MACGINITIE (1972), this conception was later completed by GRUAS-CAVAGNETTO (1977) with French data. On the basis of the

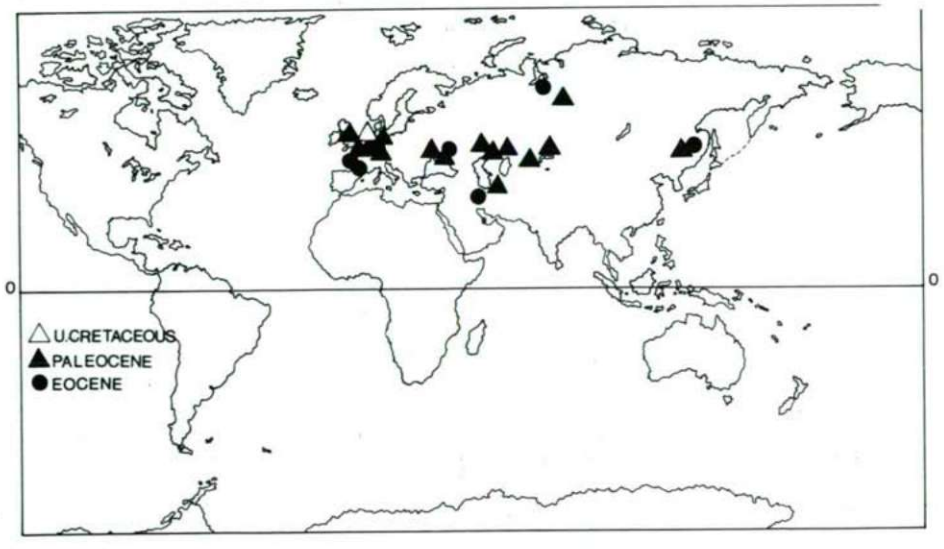

Fig. 2. Regional distribution of *Triatriopollenites roboratus* PF. 1953 during the Upper Cretaceous and the Tertiary.

distribution map of LEOPOLD and MACGINITIE (1972) the acme of this genus is in the Oligocene epoch. Following our new compilation (fig. 3) the pollen grains of this genus was very wide-spread in the Paleocene and the flowering age was in the Eocene. In the Oligocene its importance diminuted, but the pollen grains of this genus were remarkably distributed. As regards the Miocene age our results are identical with those of LEOPOLD and MACGINITIE (1972), namely the reduction of this genus is striking. The disappear in North America, but in Europe occur in several localities. Interesting are data from the Pliocene, in contrast that these are scarce, they came mostly from Europe. Noteworthy is the occurrence, south of the Equator, from a deep-sea drilling, near the Timor Islands.

Fgen.: *Paraalnipollenites* HILLS et WALLACE 1969 here emend

Syn.: 1976, SUNG TZE-CHEN et TSAO LIU. — *Fushunpollis* gen. nov., p. 155.

Fgen. Type: *Paraalnipollenites alterniporus* (SIMPSON 1961) SRIVASTAVA 1975 (Plate I, fig. 9-12)

Syn.: 1961, SIMPSON. — *Alnus alternipora*, p. 443, pl. 13, fig. 5.
1963, ZAKLINSKAYA. — *Triatriopollenites confusus*, p. 232, pl. 34, fig. 7, cf. 6, 8.
1969, HILLS and WALLACE. — *Paraalnipollenites confusus* (ZAKLINSKAYA) n. comb., p. 141, pl. 17, figs. 1-8.
1976, SUNG TZE-CHEN and TSAO LIU. — *Fushunpollis arcuatus* sp. nov., p. 155, 156, pl. II, figs. 32-38.

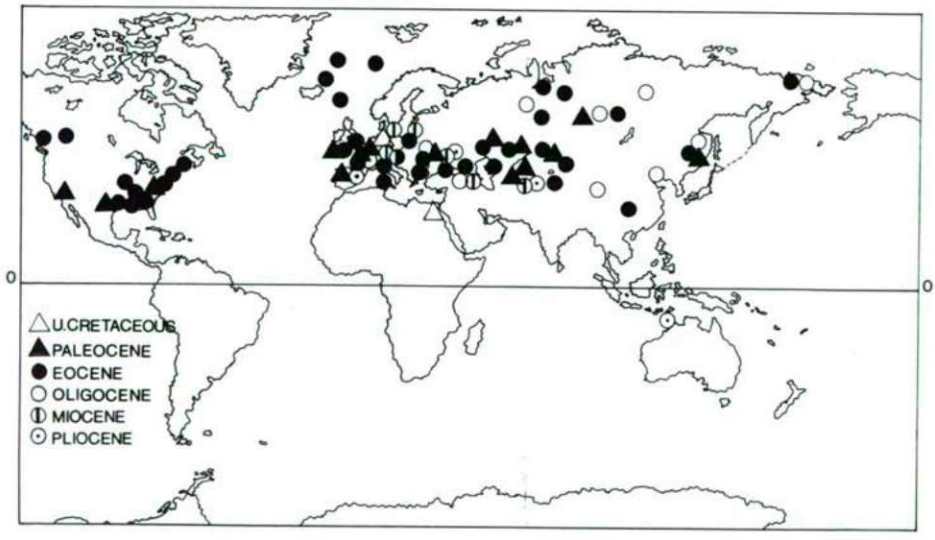

Fig. 3. Regional distribution of *Platycaryapollenites* E. NAGY 1969 emend. FREDERIKSEN et CHRISTOPHER 1978 during the Upper Cretaceous and the Tertiary.

Emended diagnosis

Triatriate pollen grains. On one of the hemispheres there is a thickening form of a ring, and there are arci too. The form and the thickness of the arci is varied. By LM method no characteristic sculpture may be detected.

Remarks. — The pollen grains, which may be classed into this form-genus have four important morphologic characteristic features: 1. the atrium, 2. the polar thickening form a ring, 3. the arci, 4. the more or less smooth surface.

Differential diagnosis

The joint presence of the above enumerated characteristic features well distinguish from the pollen grains of *Triatriopollenites* PF. 1953 and *Plicapollis* PF. 1953.

On the basis of the first data, which were reviewed by HILLS and WALLACE (1969) it seemed that the pollen grains of this form-genus are the elements of the *Aquilapollenites* province, and because of its restricted, Maestrichtian, and Paleocene occurrence, have a stratigraphic importance. The earliest data were published from the Turonian of Europe, this is unique, but no microphotographs accompanied this finding (PACLTOVÁ, 1973) so it was no taken into consideration of the time being. In this way the appearance remain the upper part of the Upper Cretaceous. The youngest occurrences are as follows: Eocene/Oligocene: Far East, Eocene ?Oligocene: China, Region of Bohai. There are well established occurrences from Europe and Siberia. It is interesting that from the Eocene period these pollen grains were not found from localities studied palynologically in North America (fig. 4).

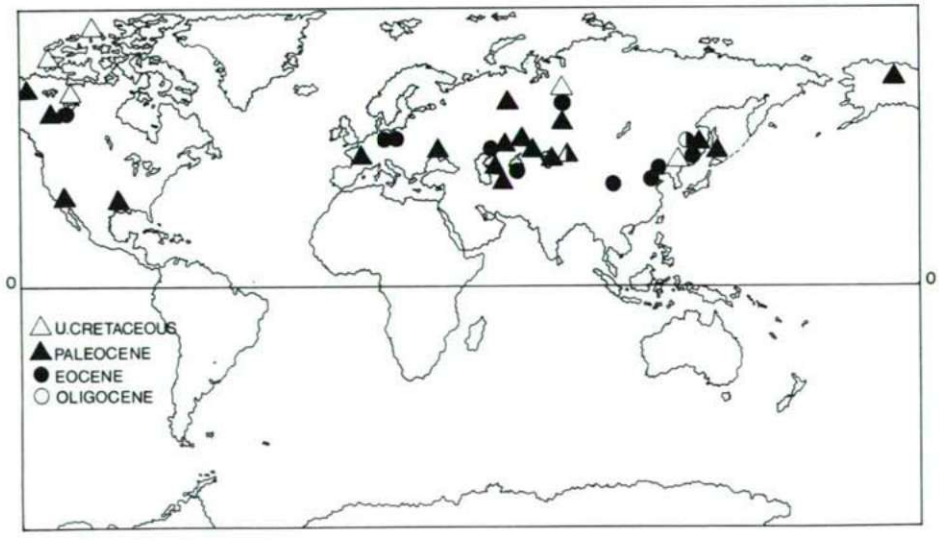

Fig. 4. Regional distribution of *Paraalnipollenites* HILLS et WALLACE 1969 emend. during the Upper Cretaceous and the Tertiary.

The plants producting of these pollen grains have probably very peculiar ecologic pretensions. In Western Europe there is only one occurrence, published from the Paleocene of Menat, France in contrast that there are studied several localities, which are rich in sporomorphs. Similarly, Eocene is also well known in Europe, but this genus was demonstrated only from two localities of Poland, and from the Black Sea Region. In this way the occurrence in Europe in the *Normapolles* province is scarce. Not yet found in the sub-province of the Atlantic Coast of North America.

Conclusions

1. The regional distribution of all *Postnormapolles* taxa discussed in this paper overstep the borders of the *Normapolles* province.
2. The geographical and stratigraphical occurrence of the most ancient types of triporate and triatriate pollen grains reveals to the heterogeneous origin of the *Postnormapolles*.
3. The paleophytogeographic elaboration of the *Postnormapolles*, *Longaxones* and other kind of pollen grains may give new ideas to our knowledge about the vegetation history.

ACKNOWLEDGEMENTS

On my request, SUNG TZE-CHEN (Nanking Instituite of Geology and Palaeontology, Academia Sinica) was kind enough to translate the Chinese text into English about the genus *Fushunpollis*. I express my sincerest thanks for this contribution.

Appendix

The data of the following publications were used for the distribution maps.

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1967, Rev. Palaeobotan. Palynol. 2, 119-126.; BRATSEVA, 1969, Akad. Nauk SSSR, 207, 1-56.; BRELIE, QUITZOW — STADLER, 1969, Fortschr. Geol. Rheinld. u. Westf. *17*, 27-40.; CARATINI 1975, B.S.G.F. *17*, 797-802.; CAVAGNETTO, 1964; Rev. de Micropaléont. *7*, 57-64.; CHATEAUNEUF, 1971, Bull. du B.R.G.M. *1*, 16-19.; CHRISTOPHER, PROWELL, REINHARDT — MARKEWICH, 1980, Palynology *4*, 104-124.; DEMARCQ, MÉON-VILAIN, MIGUET — KUJAWSKI, 1976, Serv. Géol. de Tunisie, *42*, 97-147.; DISTANOV — KUSNETZOVA, 1971, Trud. Geol. Inst. (Kazan) *20*, 234-239.; DOERENKAMP, JARDINÉ — MOREAU, 1976, Bulletin of Canadian Petroleum Geology *24*, 372-417.; DRUGG, 1967, Palaeontographica *B*, *120*, 1-71.; DURAND, 1957, C.R. des séances de l'Acad. Sci. *245*, 2067-2069.; DURAND, 1958, C.R. des séances de l'Acad. Sci. *247*, 1753-1776.; DURAND, 1960a, Soc. Geol. et Min. de Bretagne N.S. *2*, 71-80.; DURAND, 1960b, Mém. de la Soc. 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